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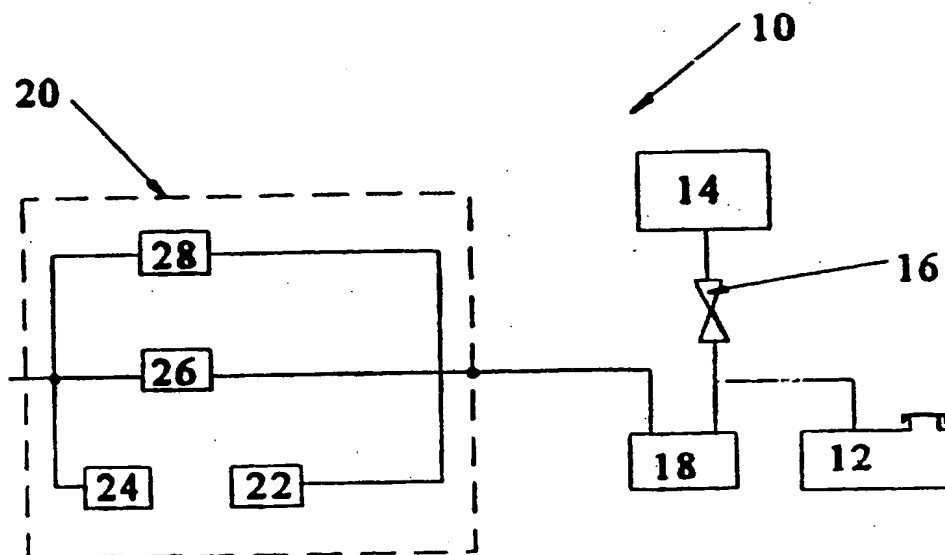
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(54) Title: INTEGRATED PRESSURE MANAGEMENT SYSTEM FOR A FUEL SYSTEM



(57) Abstract: An integrated pressure management system (20) manages pressure and detects leaks in a fuel system. The integrated pressure management system also performs a leak diagnostic for the head space in a fuel tank (12), a canister (18) that collects volatile fuel vapors from the head space, a purge valve (16), and all associated.

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## AMENDED CLAIMS

[received by the International Bureau on 15 May 2001 (15.05.01);  
new claims 19-76 added; remaining claims unchanged (12 pages)]

15. The integrated pressure management apparatus according to claim 14, further comprising:  
a ferrous armature secured to the valve, the ferrous armature being displaced in the displacement direction by the ferrous core.
16. A method of using fluid volume variations for leak detection, the method comprising:  
an actuator displacing the device.
17. The leak detection apparatus according to claim 2, wherein the actuator includes a solenoid.
18. The leak detection apparatus according to claim 3, wherein the detector includes a ferrous armature being disposed on the housing and signals] in response to displacement of the device in the chamber.
19. An integrated pressure management apparatus, comprising:  
a housing defining an interior chamber, the housing including first and second ports communicating with the interior chamber;  
a pressure operable device separating the chamber into a first portion and a second portion, the first portion communicating with the first port, the second portion communicating with the second port, the pressure operable device permitting fluid communication between the first and second ports in a first configuration and preventing fluid communication between the first and second ports in a second configuration;  
a signal chamber in fluid communication with the first portion of the interior chamber, the pressure operable device further separating the signal chamber from the second portion of the interior chamber; and  
a passageway through the housing, the passageway providing the fluid communication between the first portion of the interior chamber and the signal chamber.
20. The integrated pressure management apparatus according to claim 19, further comprising:

a solenoid displacing the pressure operable device from the first configuration to the second configuration.

21. The integrated pressure management apparatus according to claim 20, wherein the passageway is defined at least in part by a void between the housing and the solenoid.
22. The integrated pressure management apparatus according to claim 19, wherein the passageway includes an opening generally confronting the first port.
23. The integrated pressure management apparatus according to claim 19, wherein the pressure operable device includes a diaphragm separating the signal chamber and the second portion of the interior chamber.
24. The integrated pressure management apparatus according to claim 23, wherein the diaphragm includes a protrusion, and the passageway penetrates the protrusion.
25. The integrated pressure management apparatus according to claim 19, wherein the housing is an assembly of a minimum number of components with seals there between such that a number of possible leak points with respect to the interior chamber is minimized.
26. The integrated pressure management apparatus according to claim 19, further comprising:  
a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the first portion of the interior chamber.
27. The integrated pressure management apparatus according to claim 19, wherein the switch is disposed within the housing.
28. The integrated pressure management apparatus according to claim 27, wherein the switch is generally enclosed by the signal chamber.

29. A housing for an integrated pressure management apparatus, the housing comprising:  
an integral homogenous primary body partially defining an interior chamber;  
first and second ports communicating with the interior chamber;  
a component opening facilitating installation of a pressure operable device into the interior chamber, the pressure operable device separating the interior chamber into a first portion and a second portion, the first portion communicating with the first port, the second portion communicating with the second port, the pressure operable device permitting fluid communication between the first and second ports in a first configuration and preventing fluid communication between the first and second ports in a second configuration; and  
a secondary body attachable to the primary body and occluding the component installation opening.
30. The housing according to claim 29, wherein the primary body and the secondary body exclusively enclose the interior chamber having the first and second ports.
31. The housing according to claim 29, further comprising:  
a seal member interposed between the primary body and the secondary body, the seal member preventing leakage with respect to the interior chamber.
32. The housing according to claim 29, wherein the pressure operable device includes a diaphragm sealingly interposed between the primary body and the secondary body, the diaphragm separating a signal chamber in fluid communication with the first portion of the interior chamber from the second portion of the interior chamber.
33. The housing according to claim 32, further comprising:  
a passageway providing the fluid communication between the first portion of the interior chamber and the signal chamber.
34. The integrated pressure management apparatus according to claim 33, wherein the passageway includes an opening generally confronting the first port.

35. The housing according to claim 29, wherein a volume occupied by the attached primary and secondary bodies is minimized.
36. The housing according to claim 29, further comprising:  
a plurality of electrical connections interconnected with a switch disposed in the interior chamber, the switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the first portion of the interior chamber.
37. The housing according to claim 29, wherein the primary body includes a first set of connection features and the secondary body includes a second set of connection features, the first and second set of connection features being interengaged to retain the secondary body with respect to the primary body.
38. The housing according to claim 37, wherein the first and second sets of connection features include unidirectional snap fixtures
39. The housing according to claim 29, further comprising:  
an aperture through which the first and second ports communicate in the first configuration, and the pressure operable device includes a poppet occluding the aperture in the second configuration.
40. The housing according to claim 29, wherein the component opening also facilitates installation of a solenoid into the interior chamber, the solenoid displacing the device from the first configuration to the second configuration.
41. The housing according to claim 40, wherein the solenoid includes a stator extending transversely with respect to a displacement direction of the pressure operable device between the first and second configurations.

42. The housing according to claim 40, further comprising:

a passageway providing fluid communication between the first portion of the interior chamber and a signal chamber, the signal chamber is separated from the second portion of the interior chamber by the pressure operable device, and the passageway is defined at least in part by a void between the housing and the solenoid.

43. An integrated pressure management apparatus for a vehicle having an internal combustion engine, the integrated pressure management apparatus comprising:

a housing defining an interior chamber, the housing including first and second ports communicating with the interior chamber;

a pressure operable device separating the chamber into a first portion and a second portion, the first portion communicating with the first port, the second portion communicating with the second port, the pressure operable device permitting fluid communication between the first and second ports in a first configuration and preventing fluid communication between the first and second ports in a second configuration;

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the first portion of the interior chamber; and

a solenoid adapted for displacing the device from the first configuration to the second configuration during engine operation and thereby providing a performance diagnostic of the switch.

44. A volatile fuel vapor purge system for an internal combustion engine, the volatile fuel vapor purge system comprising:

a fuel tank having a headspace;

an intake manifold in fluid communication with the headspace;

a charcoal canister in fluid communication with the headspace;

a purge valve having a first side in fluid communication with the intake manifold and having a second side in fluid communication with charcoal canister and with the headspace; and

an integrated pressure management apparatus including:

a housing having an interior chamber in fluid communication with the charcoal canister;

a pressure operable device separating the interior chamber into a first portion and a second portion, the first portion communicating with the charcoal canister, the second portion communicating with a vent port, the pressure operable device permitting fluid communication between the charcoal canister and the vent port in a first configuration and preventing fluid communication between the charcoal canister and the vent port in a second configuration; and

a solenoid adapted for displacing the device from the first configuration to the second configuration during engine operation and thereby providing a performance diagnostic of the purge valve.

45. The volatile fuel vapor purge system according to claim 44, wherein the integrated pressure management apparatus further includes:

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the charcoal canister.

46. The volatile fuel vapor purge system according to claim 45, wherein the solenoid is adapted for displacing the device from the first configuration to the second configuration during engine operation and thereby providing a performance diagnostic of the switch.

47. A method of providing a performance diagnostic of a purge valve connecting a charcoal canister to an intake manifold of an internal combustion engine, the method comprising:

providing an integrated pressure management system including:

a housing having an interior chamber in fluid communication with the charcoal canister;

a pressure operable device separating the interior chamber into a first portion and a second portion, the first portion communicating with the charcoal canister, the second portion communicating with a vent port, the pressure operable device permitting fluid communication between the charcoal canister and the vent port in a first configuration and

preventing fluid communication between the charcoal canister and the vent port in a second configuration;

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the charcoal canister; and  
a solenoid adapted for displacing the pressure operable device from the first configuration to the second configuration;

actuating the solenoid during engine operation to displace the pressure operable device from the first configuration to the second configuration;

evaluating purge valve performance.

48. The method according to claim 47, further comprising:  
evaluating switch performance.

49. A fuel system for supplying fuel to an internal combustion engine of a vehicle, the fuel system comprising:

a fuel tank having a headspace;

an intake manifold in fluid communication with the headspace;

a charcoal canister in fluid communication with the headspace;

a purge valve having a first side in fluid communication with the intake manifold and having a second side in fluid communication with charcoal canister and with the headspace;  
and

an integrated pressure management system including:

a housing connected to the charcoal canister and defining an interior chamber;

a pressure operable device separating the chamber into a first portion and a second portion, the first portion communicating with the charcoal canister, the second portion communicating with a vent port, the pressure operable device permitting fluid communication between the charcoal canister and the vent port in a first configuration and preventing fluid communication between the charcoal canister and the vent port in a second configuration; and

a switch signaling displacement of the pressure operable device in response to negative pressure at a first pressure level in the charcoal canister.



50. The fuel system according to claim 49, wherein the housing defines an aperture through which the charcoal canister and the vent port communicate in the first configuration, and the pressure operable device includes a poppet occluding the aperture in the second configuration.

51. The fuel system according to claim 49, wherein the housing further defines a signal chamber in fluid communication with the charcoal canister, and the pressure operable device further separates the signal chamber from the second portion of the interior chamber.

52. The fuel system according to claim 49, further comprising:  
a minimum number of fluid communication connections.

53. The fuel system according to claim 49, wherein the pressure operable device comprises:  
a poppet preventing fluid communication between the charcoal canister and the vent port in the second configuration;  
a spring biasing the poppet toward the second configuration; and  
a diaphragm separating the second portion of the interior chamber from a signal chamber in fluid communication with the charcoal canister.

54. The fuel system according to claim 53, wherein a negative pressure below the first pressure level displaces the poppet against the spring bias to the first configuration.

55. The fuel system according to claim 53, wherein a positive pressure above a second pressure level in the signal chamber displaces the diaphragm and the poppet against the spring bias to the first configuration.

56. The fuel system according to claim 49, further comprising:  
an engine control unit operatively connected to the purge valve; and  
a plurality of electrical connections fixed to the housing and adapted to electrically interconnect the switch with the engine control unit.

57. The fuel system according to claim 56, further comprising:  
a control circuit disposed in the housing and electrically interconnecting the switch and the plurality of electrical connections.
58. The fuel system according to claim 49, further comprising:  
a solenoid displacing the device from the first configuration to the second configuration.
59. The fuel system according to claim 58, wherein the solenoid includes a stator extending transversely with respect to a displacement direction of the device between the first and second configurations.
60. The fuel system according to claim 58, wherein the charcoal canister communicates with a signal chamber via a passage defined at least in part by a void between the housing and the solenoid.
61. The fuel system according to claim 49, further comprising:  
a contiguous connection between the charcoal canister and the housing.
62. The fuel system according to claim 61, wherein the contiguous connection is selected from a group consisting of a bayonet connection, a threaded connection, and an interlocking sliding connection.
63. The fuel system according to claim 49, further comprising:  
a remote connection extending between the charcoal canister and the housing spaced from the charcoal canister.
64. The fuel system according to claim 63, wherein the remote connection is selected from a group consisting of a rigid pipe and a flexible pipe.

65. A fuel system, comprising:

a leak detector sensing negative pressure at a first pressure level in a headspace of a fuel tank, a charcoal canister, and fluid conduits interconnecting the fuel tank and charcoal canister; and

a pressure operable device operatively connected to the leak detector, the pressure operable device relieving negative pressure below the first pressure level and relieving positive pressure above a second pressure level.

66. A method of managing pressure in a fuel system including a fuel tank, a charcoal canister, and fluid conduits interconnecting the fuel tank and charcoal canister, the method comprising:

providing an integrated assembly including a switch actuated in response to the pressure and a valve actuated to relieve the pressure; and

signaling with the switch a negative pressure at a first pressure level.

67. The method according to claim 66, further comprising:

actuating the valve to relieve negative pressure below the first pressure level.

68. The method according to claim 66, further comprising:

actuating the valve to relieve positive pressure above a second pressure level.

69. A method of calibrating an integrated pressure management apparatus, the method comprising:

providing a chamber having an interior volume varying in response to fluid pressure in the chamber, the chamber including a diaphragm displaceable between a first configuration in response to fluid pressure above a certain pressure level and a second configuration in response to fluid pressure below the certain pressure level;

providing a resilient element applying a force biasing the diaphragm toward the first configuration;

providing a switch actuated by the diaphragm in the second configuration;  
connecting the chamber to a pressure source at the certain pressure level; and

adjusting the biasing force such that the switch is actuated at the certain pressure level.

70. The method of calibrating according to claim 69, further comprising:  
providing an adjuster contiguously engaging the resilient element.
71. The method of calibrating according to claim 70, wherein the adjusting includes operating the adjuster to modify the biasing force.
72. The method of calibrating according to claim 70, wherein the providing an adjuster includes providing a calibrating screw threadably mounted with respect to the chamber, and the adjusting includes turning the calibrating screw.
73. The method of calibrating according to claim 72, wherein the providing a resilient element includes providing a leaf spring having a first end fixed with respect to the chamber and a second end contiguously engaging the diaphragm, and the adjusting includes turning the calibrating screw in contiguous engagement with an intermediate portion of the leaf spring between the first and second ends.
74. The method of calibrating according to claim 72, wherein the providing a resilient element includes providing a leaf spring having a first end fixed with respect to the housing and the calibrating screw connecting a second end of the leaf spring with respect to the chamber, and the adjusting includes turning the calibrating screw to adjust spacing between the first and second ends.
75. The method of calibrating according to claim 69, further comprising:  
iterating the connecting the chamber to the pressure source and the adjusting the biasing force until the switch is actuated at the certain pressure level.

76. The method of calibrating according to claim 75, further comprising:  
disconnecting the chamber from the pressure source between iterations of the  
adjusting the biasing force.

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